

Nanoscience in the Earth and Environmental Sciences Research Community

NNCI Annual Conference, October 21, 2022



nano@stanford

Research Community for Nano-Earth Systems (nano-ES)

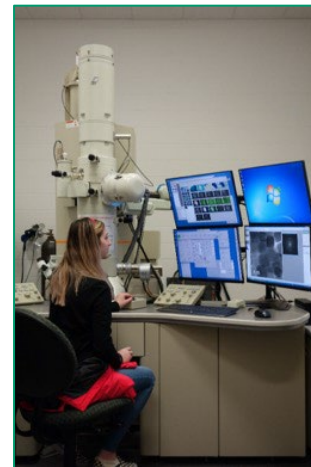
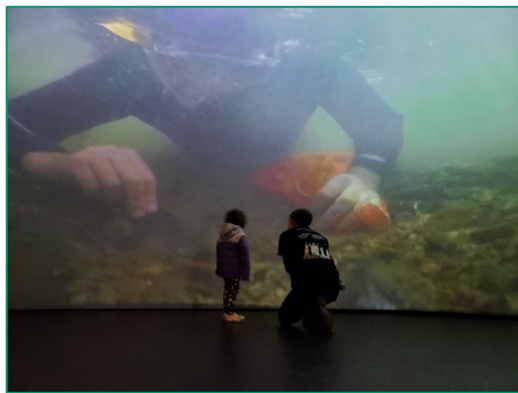
- Building upon the 2018 NSF workshop and resulting [Science paper](#), four NNCI sites will lead a Nano Earth Systems research community
- nano-ES bears upon national priorities
 - NNI Signature Initiative – [Water Sustainability through Nanotechnology](#)
 - NAE Grand Challenge - [Providing Access to Clean Water](#)
 - NSF 10 Big Ideas – [Growing Convergence Research](#)



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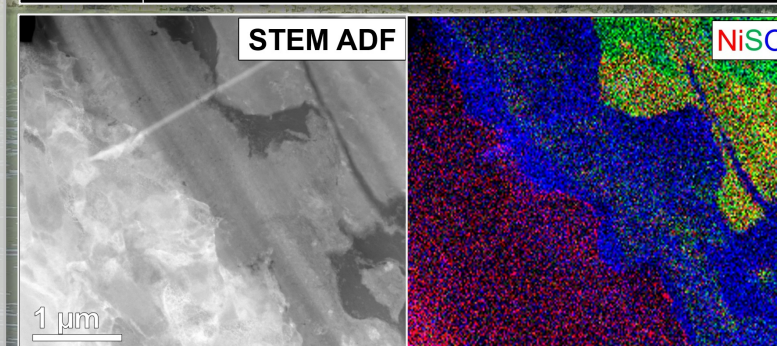
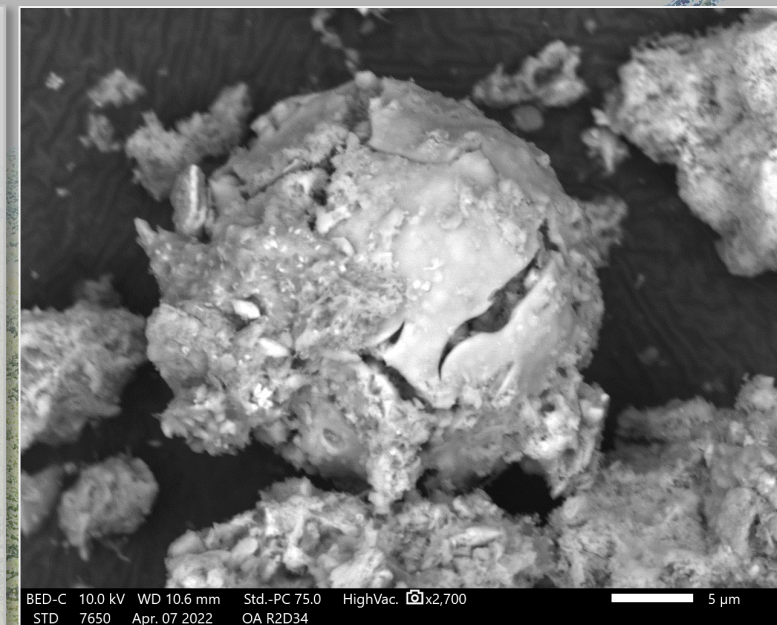
Goal: Enhance the Earth/environmental capacity and impact of the NNCI

- Develop research tools and infrastructure to provide us with the capacity to approach more complex questions than ever before;
- Train the next generation of researchers to approach scientific inquiry in a way that crosses scales and scientific disciplines;
- Foster collaboration and convergent research across the network and beyond by helping us to consider multiple levels of organization and complexity in addressing key trans-disciplinary questions.



Nanoscience in the Earth and Environmental Sciences Research Community

Virtual Workshop, May 16–18, 2022



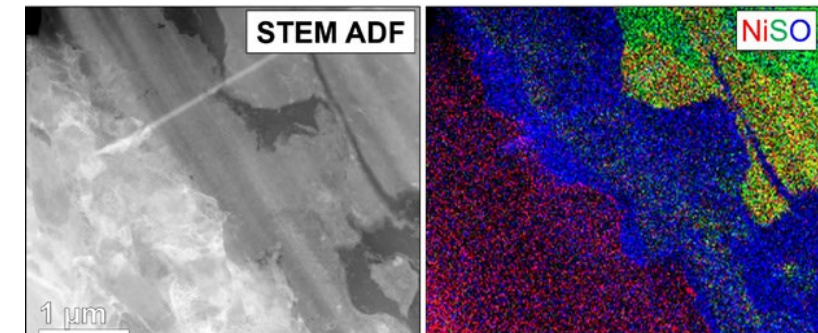
Nanoscience in the Earth & Environmental Sciences Research

Community Virtual Workshop (May 16-17, 2022 with optional 'Office Hours with Experts' on May 18)

- Designed for *nano-novices* in Earth, environmental, agricultural, water, geoscience, or related fields
- 2+ days focused on Case Studies:
 - 1) nanoparticles formed in a drinking water reservoir
 - 2) nanoscale structures in a meteorite sample
- Emphasis on collecting, preserving, and preparing environmental nano samples, instrumental data acquisition, analysis, and integration/interpretation
- 144 registrants and 65 workshop participants – very positive feedback
- All workshop materials available online

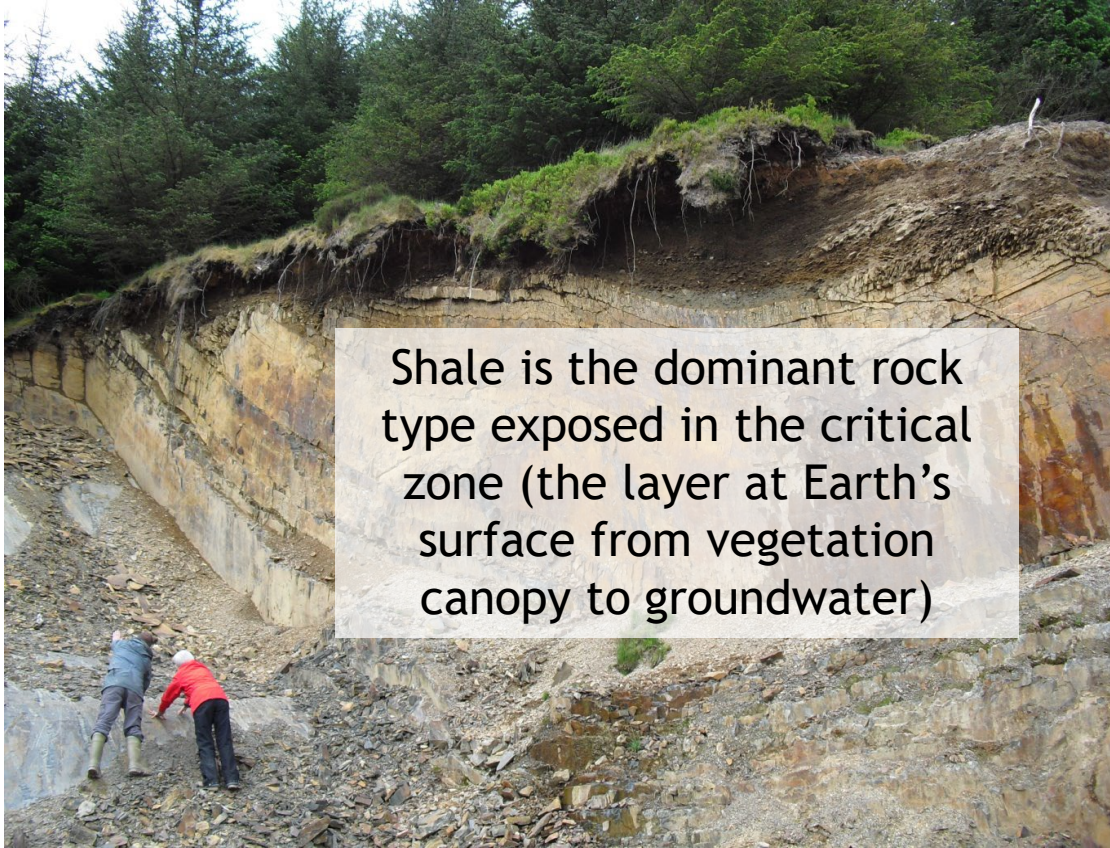


Falling Creek Reservoir (Vinton, VA), the sampling site for one of the case study examples



TEM image and compositional map of the meteorite case study sample, which illustrates boundaries between iron metal (left), magnetite (middle), and iron sulfides (right).

Deep abiotic weathering of pyrite



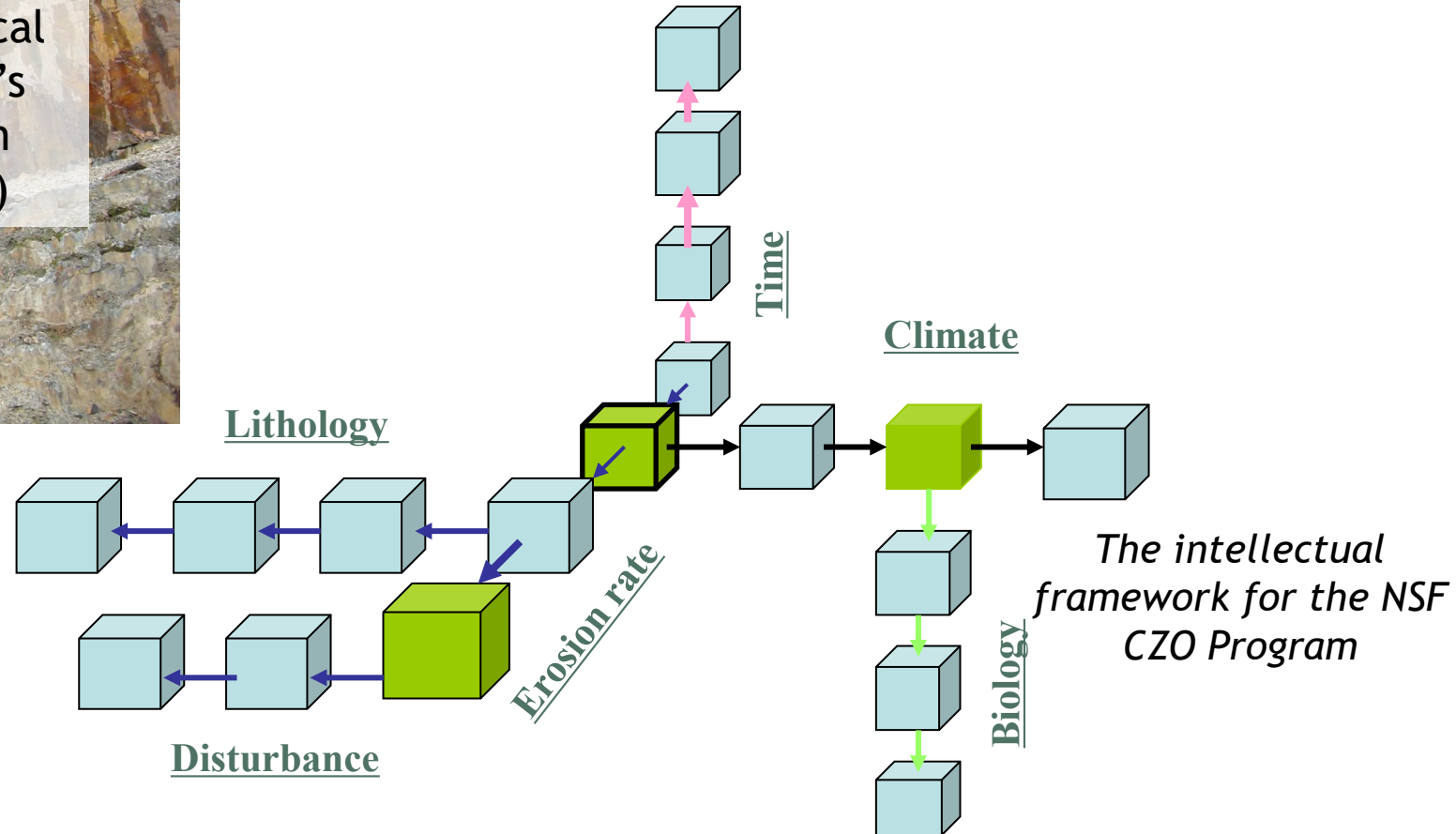
Shale is the dominant rock type exposed in the critical zone (the layer at Earth's surface from vegetation canopy to groundwater)



Susan L Brantley



We would like to understand these subsurface landscapes as a function of environmental variables



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Nanoscience in the Earth & Environmental Sciences Research Community Virtual Workshop End-of-Workshop Assessment



Workshop assessment lead by MONT partner Monica Bruckner of SERC; 15 page report available upon request.

Table 4. Participant race (n=56)

Race	Counts
American Indian or Alaska Native	1
Asian	12
Black or African American	6
Native Hawaiian or Pacific Islander	0
White	33
Prefer not to answer	4

Table 5. The gender of participants (n=56)

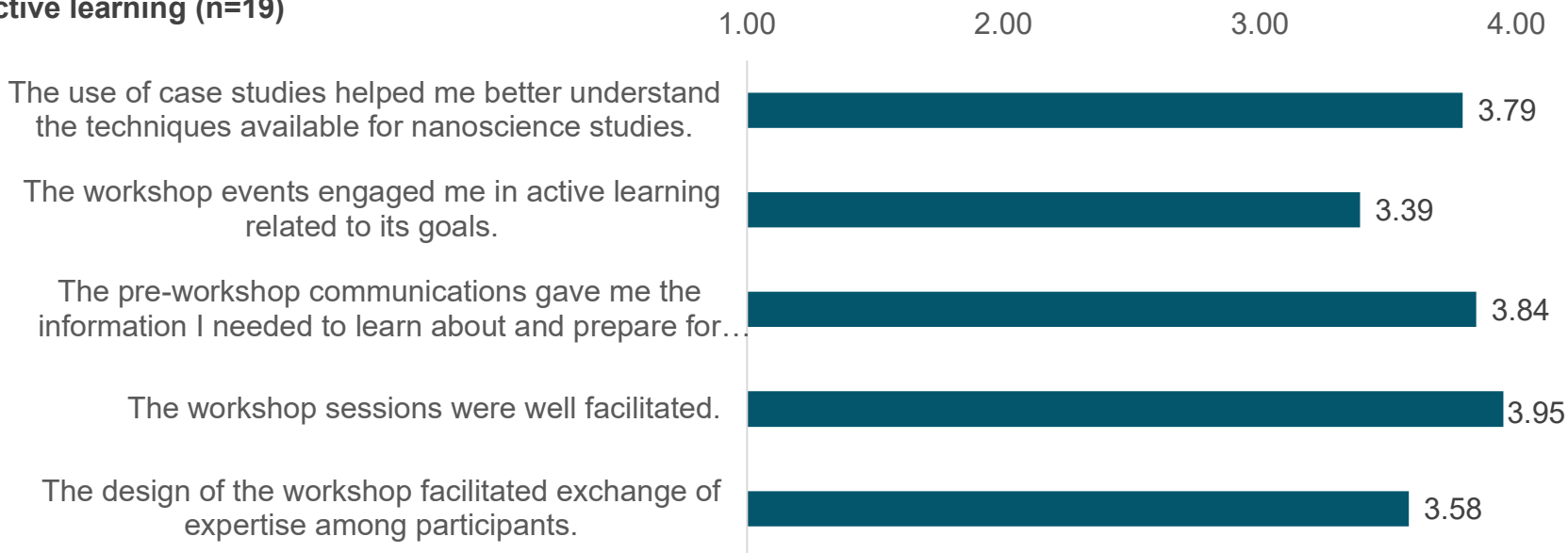
Gender	Count
Female	26
Male	29
Do not identify as male or female	0
Prefer not to answer	1

Table 6. Participant research discipline (n=57)

Discipline	Counts
Geology/Earth	44
Chemistry	21
Electronics	1
Educational Lab Use	10
Life Sciences	6
Materials	23
Medicine	1
MEMS/Mechanical Engineering	0
Optics	1
Physics	8
Process	4
Other	9

Note: Not all workshop attendees pre-registered and therefore we do not have their demographic information.

Figure 1. The mean ratings for each statement targeting workshop facilitation, communication, design, and active learning (n=19)

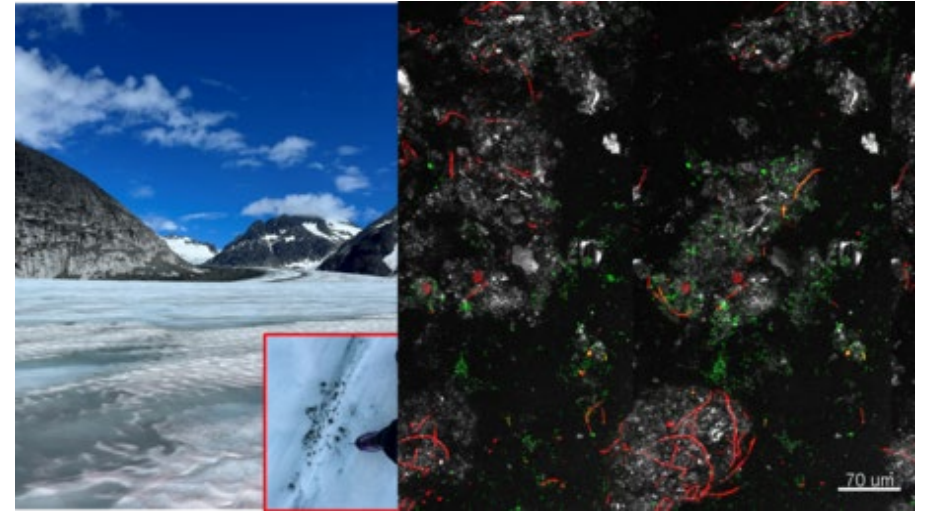


Comments from Survey Respondents

- *Excellent technology updates which will be incorporated as training updates for working TEM-EDS technicians at multiple company locations: VA, NY, MA, CA.*
- *I work with community college students. The excellent case study approach AND sample prep-related tutorials expanded my knowledge these past 9 hours. Thank you!*
- *Honestly, the videos and sessions going over the analytical instrumentation were wonderful. I am in the process of learning XRD, XPS, SEM, and other techniques. Having someone clearly and concisely explain how the instrument works, how to use the instrument, and how to interpret the data is difficult to find online.*
- *The clear descriptions of the strengths and drawbacks of the various methods of materials analysis, coupled with the real-world reports by the scientists of how they went about their analyses and use of the various instruments. All of that coupled with Q&A via chat made it a very strong workshop.*
- *It was great to see the FIB and TEM in action as I've had some experience with this, but not a lot. This relieved a bit of anxiety I have about using these instruments. I also appreciated the research case studies highlighting how nanoscience is applied, as well as the expert panel at the end; both gave me perspective on my own research regarding sample preparation and strategies for my future FIB and TEM work.*

Future Activities

- MONT is organizing a Rules of Life Research Community workshop on “The Convergence of Biology and Earth Sciences”.
November 1 12-3pm (Mountain time),
online, free (registration by Oct. 31).



- Staff exchanges
- Providing workshops and coordinating summer REU activities
- Online resources
 - Registry of Analytical Instruments Commonly Used in Earth and Environmental Science Research (https://serc.carleton.edu/msu_nanotech/instrument_registry.html)
 - Tutorial Webpages on Analytical Methods and Instrumentation Techniques (https://serc.carleton.edu/msu_nanotech/methods.html)

Gilkey Glacier, Alaska. Inset showing cryoconite sediments on glacier surface and confocal microscopy image of biofilm on the sediment surface. (image: C. Foreman, H. Smith, Montana State Univ.)

Future Activities

2023 NNCI Nanoscience in the Earth and Environmental Sciences Research Community Virtual Workshop hosted by NCI-Southwest

April 5-6, 2023 10am-2pm (Pacific time)

- Emerging Nanoscience Research for Water Purification: Nano-Enabled Treatment Processes versus Nano/Microplastics
- Emerging Nanoscience Research for Agriculture and Elemental Cycling including transient phosphorus by Jacob Jones (RTNN)
- Keynote lecture: Sustainable Nanotechnology by Julie Zimmerman (Yale Univ)
tentative?



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Questions?

Challenges: Aggregation

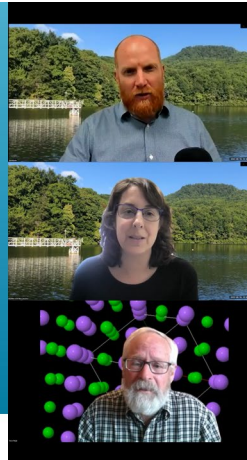
Issue: Processing steps such as filtering can result in irreversible aggregation and/or selectively remove certain size fractions

Mitigation Strategies:

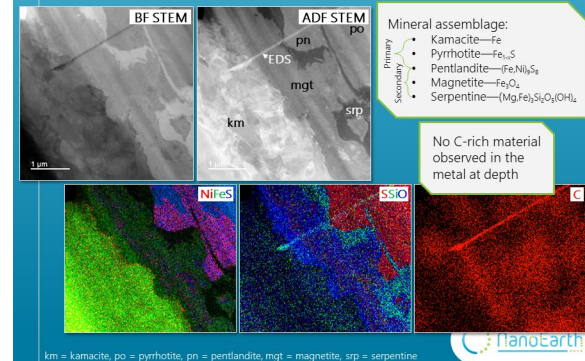
- Gravitational settling
- Centrifugation
- Drop cast with air drying
- Flash freezing



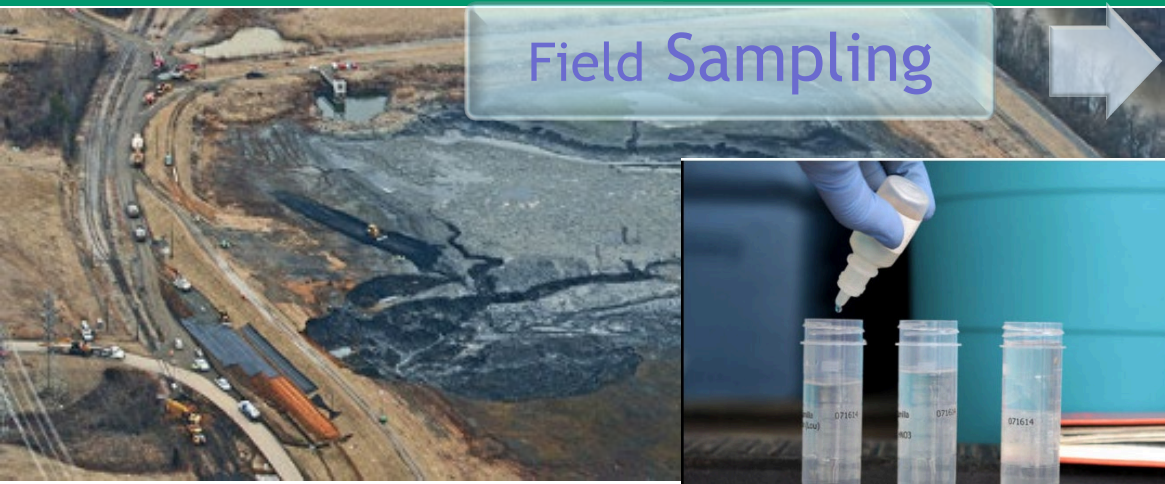
Credit: FM Michel



Sulfide-Metal Assemblages in CR2 Renazzo Mineral Assemblage—EDS



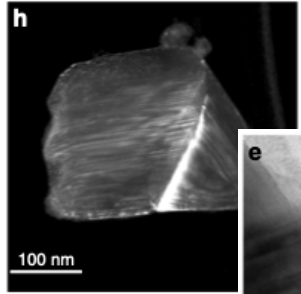
Find better ways to trace the long-term environmental implications of human activities



Field Sampling

Characterizing

Understanding



Nanomaterials

